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Target Identification Predictor Study: Visual, Cognitive, and Training Variables

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The Target Identification Predictor Study (TIPS) was designed to determine the predictive utility of visual, cognitive, and training variables upon tracked vehicle identification performance within an operational context and to provide a reliable and valid basis for a model to select antitank gunner trainees. Regression analyses performed on the scores of 208 junior enlisted soldiers showed that scores from classroom vehicle identification training and scores on the Group Embedded Figures Test were significant predictors of identification skills. Thirty-three percent of the variability was predicted by this regression. A discriminant analysis showed that these three scores could be used to classify the soldiers into good or poor target identification groups. Results from a cross validation analysis correctly classified 78.9 percent of the soldiers, indicating that this classification scheme was highly reliable. Since target identification is a critical initial task within the engagement acquisition performance complex for many weapon systems, identification of predictors of superior target identification skills (and the selection of individuals with these skills) could be an important means of enhancing target acquisition effectiveness both directly and indirectly.

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Introduction

Target identification experiments typically have considered various environmental parameters that affect human operator performance. Some of these physical determinants of target identification include: target size, shape, target/background contrast, spatial location, orientation, edge gradient, contour complexity, and illumination level. Subject responses ordinarily are grouped together to obtain "treatment effects" of various conditions imposed, with subject differences considered to be sources of error. However, individual differences may contribute to differences observed in target identification performance. Since target identification is a critical initial task in the operation of many weapon systems, identification of predictors of superior target identification skills (and the selection of individuals with these skills) could enhance target acquisition effectiveness both directly and indirectly.

For instance, earlier target identification of high threat combat vehicles could enable soldiers manning antitank weapons to exploit greater standoff ranges and thereby enhance their survival. Increased accuracy of threat vehicle identification could reduce the incidence of inadvertent fratricide and thereby increase force effectiveness during close combat. Establishing valid predictors of successful target identification could result in reduced training time and enhanced user-weapon integration. These data should contribute directly to soldier system integration initiatives (e.g. MANPRINT), where an understanding of operator capability is deemed essential to maximizing the effectiveness of all such systems (U.S. Army Regulation 602-2).

Working toward this goal, the approach with the Target Identification Predictor Study (TIPS) was to build a partial selection model from an array of visual, cognitive, and training variables which have previously demonstrated promising results with respect to field target acquisition and/or identification.

The National Research Council's Committee on Vision has endorsed the idea of using visual function tests to identify military personnel with superior skills in target acquisition (Committee on Vision - National Research Council, 1985). However, in terms of target acquisition performance, the predictive capabilities of the visual variables remain an equivocal (or in some cases, an unexplored) issue. Grossman & Whitehurst (1976, 1979) examined the effects of visual acuity on the acquisition of scale-model, terrain board tank targets, but could not predict success using a hit/miss performance criterion. Ginsburg (1980, 1981) has argued that individual visual performance is best characterized using the contrast sensitivity function and has demonstrated that correlations between measures of contrast sensitivity and visual acuity are generally low. More importantly, from the perspective of the present study, he found that the different contrast sensitivity levels shown by aviators (a group of individuals with normal and narrowly distributed acuities) may provide a singular capability for predicting individual target acquisition performance in both the laboratory and the field (Ginsburg et al., 1982; Ginsburg, Easterly, & Evans 1983a, 1983b). However, not all the results of studies on the relationship between contrast sensitivity and target acquisition performance have been as supportive (Kruk et

al., 1981, 1983; Kruk & Regan, 1983; O'Neal & Miller, 1987).

Several authors have addressed the importance of color vision (Hilgendorf & Milenski, 1974; Collins & Whittenburg, 1974; Greening, 1975) and stereoscopic vision (Lotens & Walraven, 1974; Home, 1977) in field tests of target acquisition. However, the role of individual differences in color discrimination and stereopsis remains ambiguous. There are anecdotal reports supporting the notion that color defectives should exhibit superior detection skills for camouflaged targets (e.g., Judd, 1943; Kalmus, 1965), but the available experimental evidence is contradictory. Wallace, Hexter, & Hecht (1943), and Whittenburg & Collins (1974), were unable to support the relationship of color deficiency and superior target acquisition performance. Julesz's (1971) work with random dot patterns showed that, even under conditions of perfect camouflage, an object will still be seen when there is a difference in depth. A few technical reports of attempts to replicate Julesz's basic findings with military targets in the field have shown that for targets presented in an actual field setting or embedded within a slide, target acquisition with binocular vision exceeds that with biocular or monocular vision, especially under conditions of threshold contrast (Lotens & Walraven, 1974; Home, 1977). Unfortunately, no data currently exist linking differential target acquisition (detection or identification) with individual differences in stereopsis.

Nevertheless, individuals with similar or even identical visual attributes may still exhibit differences in extracting (detecting or identifying) objects (or other information/stimuli) within their respective visual fields. The stage beyond the mere physical recording of the visual sensation is one primarily of processing, or perceptual restructuring, of the visual input. The characteristic way in which an individual processes is called his perceptual style (Witkin, 1949; Witkin et al., 1962) and is considered to be a stable aspect of each individual's personality. One such style, field dependence-independence, is considered to be independent of measures of visual function (Barrett, Cabe & Thornton, 1967, 1968; Kinney & Luria, 1980). Several authors have examined field independence/dependence in relation to the problems of target acquisition performance in detecting geometric shapes and military vehicles, the detection and interpretation (identification) of aerial photographic targets, and aircraft identification performance among STINGER gunners (Bucklin, 1971; Whittenburg & Collins, 1974; Miller, 1985; McDonald & Eliot, 1987). In general, field independent subjects were better able to separate a target figure from the surround in which it was embedded. Field dependent individuals were characteristically the opposite, possessing little ability for spatial reorganization and having difficulty in separating an item from its context.

Several investigators have examined scores from the Armed Services Vocational Aptitude Battery (ASVAB) in an attempt to predict target acquisition performance. The ASVAB is a 334-item paper-pencil test taken by all enlisted soldiers to assist in classifying them according to their vocational interests and aptitudes. The test consists of 10 subtests: General Science (GS), Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Completion (PC), Numerical Operations (NO), Coding Speed (CS), Auto and Shop Information (AS), Math Knowledge (MK),

Mechanical Comprehension (MC), Electronics Information (EI), and Verbal (VE), which is the sum of WK+PC. These scores are combined into the Army service composite factors shown in table 1.

Table 1.
Components of the Army service subscales.

Army service composite factor	Definition
Armed Forces Qualifying Test (AFQT)	2(VE) + AR + MK
General Technical (GT)	VE + AR
General Maintenance (GM)	MK + EI + AS + GS
Electronic Repair (EL)	AR + MK + EI + GS
Clerical (CL)	AR + MK + VE
Motor Maintenance (MM)	NO + AS + MC + EI
Signal and Communication (SC)	AR + AS + MC + VE
Combat (CO)	CS + AR + MC + AS
Field Artillery (FA)	AR + CS + MC + MK
Operations and Food (OF)	NO + AS + MC + VE
Skilled Technical (ST)	VE + MK + MC + GS

Stewart, Christie, & Jacobs (1974) explored the ability of the ASVAB to predict tracking performance with the Dragon training apparatus[1]. Although they succeeded, predictors for this performance differed from those using the actual system and failed to correlate with live fire hit or miss. In contrast, a study reported by Cartner et al., (1985) showed that scores on several scales of the ASVAB did significantly discriminate between live fire success and failure. Similarly, a regression analysis by Derhammer et al., (1976) indicated the General Maintenance composite test score to be the most efficient predictor of performance -- a none too surprising finding, considering the predominant psychomotor nature of their performance criteria. Interestingly, Derhammer et al. recognized the limitations of their study (and acknowledged the relevance of visual skills) by concluding that "...General Maintenance Aptitude obviously cannot be allowed to loom in greater significance than ... the visual traits required to acquire targets at maximum range" (p.52).

As noted above, attempts to discern individual-based predictors of antitank gunnery performance and certify their validity have been only marginally successful. Due to the propensity of workers to focus their attention on limited aspects of performance, namely tracking and aiming, reliable predictors of the preceding target acquisition behaviors remain unexplored,

1. The Dragon, first deployed in 1975, is a medium range, wire-guided antitank missile that is light enough to be carried by a single infantryman.

and the few factors that have been demonstrated to predict accuracy in tracking and aiming remain unimplemented. As a result of the Army's inability to realize an adequate anti-armor personnel selection program, Chitwood (1985) advised the Army as late as 1985 to reduce the annual TOW gunnery attrition rate and decrease training dollar losses by developing and implementing an objectively-based antitank gunner selection model. Such selection models have been used in the past to buffer imposed manpower and materiel resource constraints, reduce training time and costs, increase training proficiency, and improve the chances for training success by "improving the quality of personnel selected" for specific training programs. Accordingly, tactical planners have placed great emphasis on the recognition-identification components of the target acquisition performance matrix. In accordance with past attempts to identify effective predictors of target identification performance, TIPS was designed to provide initial criteria and a potential methodological approach for selecting personnel for antitank gunnery.

Methods

Subjects

Junior enlisted soldiers (272 males), recent graduates of Infantry One Station Unit Training at Fort Benning, Georgia, served as volunteer subjects, and signed voluntary informed consent forms prior to their participation. They were encouraged to ask questions and were permitted to withdraw from the study without prejudice or penalty. All soldiers had been awarded the 11B military occupational specialty -- Infantry Rifleman (i.e., the potential pool of antitank gunner eligibles). Soldiers with additional skill identifiers showing that they had received additional or specialized target identification training were excluded from participation. Volunteers were recruited and tested in groups from 30 to 50 soldiers per week.

Test site

Field trials were conducted on an unused drop zone in the southwest corner of Fort Benning. The ground plane at this location was moderately flat (few terrain folds and undulations) with a generally uninterrupted line-of-sight of approximately 1500 meters from the designated test observer positions. The site was uncluttered, providing an effective field-of-view of greater than 60 degrees; existing terrain and foliage at the distal end of the range provided a "natural" target surround. The field was cleared by post engineers approximately one month before test start-up, to ensure unobstructed viewing.

Target vehicles

Nine U.S. Army tracked combat vehicles were used in the field trials: (1) the M60 Main Battle Tank, (2) the M2 Bradley Fighting Vehicle, (3) the M113 Armored Personnel Carrier, (4) the M109 Self-propelled Howitzer, (5) the M901 Improved TOW Vehicle, (6) the M577 Command Post Carrier, (7) the M548 Tracked Cargo Carrier, (8) the M88 Armored Recovery Vehicle, and (9) the M578 Light Armored Recovery Vehicle. The presence or absence of tracks or wheels did not serve as a cue to target identification, since all vehicles were tracked. To reduce glint-related cues (e.g., identification cues from window location), sources of potential specular reflection (e.g., shiny metal surfaces, windows, etc.) were concealed.

Test materials and instrumentation

Cognitive tests

The volunteers received several paper-and-pencil tests of cognitive function. Whenever possible, the tests were selected based on published reports suggesting a possible relationship between a specific cognitive skill and some aspect(s) of target identification performance. Because such data were limited, selection was based also upon estimates of the relationship between a particular factor as measured by the test, and target identification performance. In some cases, an individual factor was represented by more than one single test. The decision to include additional tests for a particular cognitive skill was based primarily upon (1) disagreement in the literature as to the degree of common factor loading among the tests; and (2) an inferred correspondence between the tasks presented in the cognitive test and those required in the field. The specific tests, cognitive factors, and measured cognitive abilities are shown in table 2.

Except for the Group Embedded Figures Test (Oltman, Raskin, & Witkin, 1971), all the tests were from the Educational Testing Service Kit of Factor-Referenced Cognitive Tests (Ekstrom, et al., 1976). All tests required at least minimal reading skills. Tests were administered according to standardized procedures (Ekstrom et al., 1976; Witkin et al., 1971).

Table 2.
Instruments selected for cognitive test battery.

Test	Factor	Cognitive skill
Hidden Figures Hidden Patterns	Flexibility of closure	Ability to hold a given visual percept or configuration in mind so as to disembed it from other well-defined perceptual material
Gestalt Completion Snowy Pictures	Speed of closure	Ability to unite an apparently disparate perceptual field into a single concept
Identical Pictures	Perceptual speed	Speed in comparing figures or symbols, scanning to find figures or symbols, or carrying out other very simple tasks involving visual perception
Card Rotations	Spatial orientation	Ability to perceive spatial patterns or maintain orientation with respect to objects in space
Maze Tracing	Spatial scanning	Speed in exploring visually a wide or complex spatial field
Shape Memory	Visual memory	Ability to remember the configuration, location, and orientation of figural material
Picture-Number	Associative memory	Ability to recall one part of a previously learned but otherwise unrelated pair of items when the other part of the pair is presented
Group Embedded Figures	Field dependence /independence	Competence at disembedding figure from ground

Visual function tests

Selection of specific tests for the visual functions test battery was based on: (a) judged or empirically determined significance as a predictor of some aspect(s) of target identification; (b) current or inferred utility and ease of administration as a screening and/or diagnostic instrument at the reception station or earlier level of medical evaluation; and (c) available evidence for test-retest reliability (table 3).

Table 3.
Items selected for visual test battery.

Item	Visual function
Armed Forces Vision Tester	Fusion, depth perception, distant lateral phoria
Randot, Titmus, and Verhoeff Tests	Stereopsis
Pseudoisochromatic Plates (PIP)	Red/green color vision
Ferris/Bailey Acuity Charts	High contrast letter acuity
Regan Acuity Charts	Low contrast letter acuity
Vision Contrast Test System	Contrast sensitivity
Okuma Color Plates	Isoluminant chromatic spatial detail vision
Sighting Dominance Tests	Sighting eye dominance

Acuity and contrast sensitivity tests were administered both monocularly and binocularly. Spectacle wearers were tested with and without spectacle correction. Standardized tests were administered according to recommended procedures (Ferris et al., 1982; Ginsburg, 1984; Regan & Neima, 1983). Objective refractions were obtained for all subjects with the Humphrey Automated Refractor, and subjects' spectacle prescriptions were verified with the Humphrey Autolensometer.

ASVAB scores

ASVAB Army composite scores and subtest components have been described previously. (table1). Soldiers' service composite scores were obtained from official records. Although from the standpoint of accounting for variance, full least squares estimates based upon the subtests would have been preferable, these scores were not available.

Combat vehicle identification (CVI) training materials (Government Training Aid (GTA) 17-2-9, "Combat Vehicle Identification Training Program")

This program consists of a pretest, six training modules, and a final test module. Each training module contains a series of 35mm transparencies of five different vehicles (30 vehicles total, NATO and Warsaw Pact), each vehicle in HO scale (1:87) and in five different views (side right, side left, oblique right, oblique left, and front). To provide a degree of realism, the models were photographed on a detailed terrain model under simulated daylight conditions. The final test module, administered after the trainee had completed the six training modules, contained slides of all the different vehicles included in the training modules. Both training and testing materials included a standardized narrative to ensure uniformity of presentation by the instructors. CVI training and test modules were presented in a battalion-sized classroom. Slides were shown via frontal projection. The volunteers were seated at various distances from the

screen, and the size of the projected image was adjusted to simulate a naked eye target viewing distance of approximately one half of a kilometer.

Procedures

Testing was conducted over 5 to 7 days in four sequential phases: (1) vision testing, (2) cognitive testing, (3) CVI classroom instruction, and (4) field testing. Prior to participation, volunteers were thoroughly briefed on the testing procedures, and ametropes were instructed to wear their spectacle correction during testing. In addition, subjects' medical records were available for inspection.

On the first test day, volunteers were divided into two groups in the morning, one group each for visual functions or cognitive testing. In the afternoon, they were given a block of classroom CVI instruction. On the second day, the previous morning assignments were reversed. On the second afternoon, subjects were given additional training in combat vehicle identification. At the end of the day, the soldiers were taken to the test site and familiarized with the area and actual test vehicles.

Field testing began on the third day and continued for 2 to 3 days, subject to weather conditions and subject availability. Volunteers were briefed on the nature of the required task and data recording procedures, and were then formed into four to five 8-10 man squads for target identification testing.

A 50 point (5 columns x 10 rows) target location matrix was established and target positions were marked on the field. Horizontally, targets were in one of five columns, each column separated by 25m. In depth, the 10 target points ranged from 400 to 1300m in intervals of 100m. Three to five targets were presented on any given trial, with both target type and target location presented randomly and exhaustively until each target was presented once at each range. Each subject thus viewed a total of 90 targets (9 targets at 10 ranges) over a total of 25 trials. All targets were presented in an oblique orientation; i.e., with the long axis of the target vehicle at an angle of 45 degrees drawn to an imaginary perpendicular line bisecting the center of the observation line.

Subjects not on the observation line remained behind an embankment to avoid visual contact with the targets. At the start of each trial, soldiers were brought by squads, one squad at a time, and individually positioned three meters apart along the observation line. (Soldier positions on the observation line were varied randomly from trial-to-trial to balance observer-position effects). Subjects were permitted 2 minutes to view the target array and record their responses. The nomenclature of all vehicles (but not their images) was available to each subject for reference. Subject responses were recorded by data collectors stationed on the observation line. Targets and target positions were changed only after each squad had viewed each vehicle array. A new target matrix was used each week with each new group of subjects.

An individual trial required approximately 20 minutes for each target array. This included the viewing interval (2 minutes per squad) and the times required to move subjects to and from the observation line and to transport vehicles to and from their respective target points. Subjects thus received approximately 3 trials per hour and from 8 to 12 trials per day.

Results

The major objective of TIPS was to determine those visual, cognitive, training, and ASVAB factors that may optimally predict the performance of target identification in the field. Any predictor variables so isolated may then be implemented in developing a strategy or a selection model for selecting candidates for tasks and jobs requiring high proficiency in target identification. The criterion variable in this study was the number of correct identifications made during the field trials.

All variables first were examined for accuracy of data entry, missing values, and fit between their distributions and the assumptions of multivariate analysis using STATISTICA 5.1® (Statsoft, 1996). Data from the first week ($n = 49$) were not used because several target vehicles could not be transported to the test site on time. Fifteen cases lacked entire subsections of data (e.g., no cognitive data, no target ID scores, etc.). These cases were deleted and the remaining 208 cases were retained for the analyses. The remaining missing values (<0.1 percent) were scattered randomly through the data matrix and were omitted pairwise during each analysis, where required. To improve pairwise linearity and residuals and to reduce extreme kurtosis and/or positive skewness, data distributions that did not meet the assumption of normality were transformed where applicable.

The main analyses employed were multiple regression analysis and discriminant analysis. To keep the ratio between cases and predictor variables at 20:1, each of the predictor domains (visual tests, cognitive tests, CVI training, and ASVAB scores) was analyzed separately using a backward stepwise multiple regression procedure. The backward procedure, when used as an exploratory technique for model-building, is useful in eliminating superfluous variables to tighten up further analyses. When applied to the cognitive tests, only the Group Embedded Figures Test (GEFT) contributed significantly to prediction of number of vehicles identified correctly. Likewise, analysis of CVI training revealed that the inverse of the pretest (1/pretest) and the reflected square root of the posttest were significant predictors of target identification performance. The ASVAB service composite scores revealed only the square root transformation of FA scores to be a significant predictor.

In contrast, the data for the vision tests were "singular and ill conditioned" due to high multicollinearity and could not be analyzed as entered. Upon further inspection of the intercorrelation matrix, it seemed that a factor analysis might reveal the functional unity among

the vision variables (i.e., whether variables with high intercorrelations could be combined along a single dimension and treated as an independent factor). Principal factors extraction with varimax rotation was performed on the data, and 4 orthogonal factors were extracted from the 25 variables; visual acuity, depth perception, color vision, and contrast sensitivity. However, the resulting factor scores, when regressed, did not significantly predict target identification performance. We believe this lack of predictive ability reflects the narrow distribution of visual data – nearly all of the volunteers satisfied the E-1 visual medical fitness (PULHES) requirement – a standard based primarily on visual acuity (Walsh & Levine, 1987). Consequently, attempts to code the data with categorical "dummy" variables (color deficient vs. color vision normals, stereo deficient vs. depth perceptive normals, ametropes vs. emetropes, etc.) were equally unsuccessful due to proportionally low numbers of subjects in the deficit categories.

A standard multiple regression was performed using the number of correct target identifications as the criterion variable and the four predictor variables; GEFT, CVI pretest, CVI posttest, and the FA composite scores. No cases had missing data. With the use of a $p < 0.001$ criterion for Mahalanobis distance, one multivariate outlier among the cases was found and deleted from the analysis. Table 4 displays the correlations between the variables, the unstandardized regression coefficients (B) and intercept, the standardized regression coefficients (β), the semipartial correlations (sr^2) and R, R^2, and adjusted R^2. R for the regression, .58, was significantly different from zero, [$F(4, 203) = 25.01$, $p < 0.0001$].

Table 4.
Results from regression analysis.

Variables	ID (DV)	GEFT	FA	CVI Pre	CVI Post	B	β	sr^2 (unique)
GEFT	.41					0.43*	0.155	.02
FA	.34	.52				3.46	0.134	.01
CVI Pre	-.38	-.28	-.12			-1407.22*	-0.179	.02
CVI Post	-.50	-.44	-.35	.48		-13.41*	-0.303	.06
						Intercept = 46.69		
$\bar{x}$	51.84	9.56	10.28	0.02	1.05			R^2 = .33
SD	14.74	5.36	0.57	0.002	0.33			Adjusted R^2 = .32
								R = .58
* $p < 0.05$		Unique variability = .11			Shared variability = .22			

Only three of the independent variables (IVs) significantly predicted the correct number of field identifications, GEFT ($sr^2 = .02$), inverse of the CVI pretest scores ($sr^2 = .02$), and log of the reflected CVI posttest scores ($sr^2 = .06$). Although the correlation between FA composite scores and correct number of field identifications was .34, FA composite scores did not contribute

significantly to the regression. The four IVs in combination contributed another .22 in shared variability. Altogether, 33 percent (32 percent adjusted) of the variability in correct number of field identifications was predicted by knowing scores on these four IVs. The final regression equation was:

$$\Sigma ID_{correct} = 46.69 + .43(GEFT) + 3.46\sqrt{FA} - 1407.22\left(\frac{1}{CVI_{pretest}}\right) - 13.41[\log(126 - CVI_{posttest})]$$

A direct discriminant function analysis was performed using the three significant regressor variables as predictors of membership in either good or poor target identification groups. Good and poor individuals were defined, respectively, as those with a correct number of identifications above or below the sample mean. Of the 208 cases, 116 were classified as good and 92 were classified as poor. The discriminant function resulted in a $X^2(3) = 63.7$, $p < 0.0001$. The classification functions sorted individuals into a predicted group based on which yielded a higher solution. Predicted classifications matched the prior probabilities from the sample proportions (93 poor cases and 115 good cases). Classification procedures for the total usable sample of 208 volunteers correctly classified 155 (74.5 percent), compared with 105.3 (50.6 percent) that would be correctly classified by chance alone (table 5). The incorrect classifications were distributed equally between misses (n=27) and false alarms (n=26). The classification functions and matrix are illustrated below:

Table 5.
Classification matrix from discriminant analysis.

		Predicted ⇓		
		Poor	Good	Total
Observed ⇒	Percent correct	p = 0.44	p = 0.56	p = 1.00
Poor	71.74	66	26	92
Good	76.72	27	89	116
Total	74.52	93	115	208

$$Group_{poor} = -44.425 + 0.757(GEFT) + 4720.773\left(\frac{1}{CVI_{pretest}}\right) + 7.8[\log(126 - CVI_{posttest})]$$

$$Group_{good} = -39.355 + 0.829(GEFT) + 4570.915\left(\frac{1}{CVI_{pretest}}\right) + 4.691[\log(126 - CVI_{posttest})]$$

The stability of the classification procedure was checked by a cross-validation run. Approximately 25 percent of the cases were withheld from calculation of the classification functions in this analysis. For the 75 percent of the cases from whom the functions were derived, there was a 74.36 percent (116/156) correct classification rate. For the cross-validation cases,

classification actually improved to 78.85 percent (41/52), demonstrating a high degree of consistency in the classification scheme.

Discussion

TIPS was designed to determine the predictive value of selected subjective variables upon ground-to-ground tracked vehicle identification performance within an operational context and to provide a reliable and valid methodological approach for developing a partial selection model for the future selection of antitank gunner trainees. Using regression procedures, the large array of variables was reduced to three that were significant predictors of identification skills: pretest and posttest scores from classroom vehicle identification training and GEFT scores. A discriminant analysis demonstrated that these three scores can be used to classify 74.5 percent of the soldiers into good or poor target identification groups correctly. Results from a cross validation study indicated that this classification scheme was highly reliable.

Despite the apparent success of the selection model, we stress that this is only a partial and preliminary model. These subjects were tested under optimal conditions using stationary targets under excellent observation conditions. However, real battlefields involve highly mobile and destructive weaponry, violent combat, continuous maneuver, and decentralized command and control. Indeed, future warfare will have a degree of intensity, fluidity and lethality previously unknown. Antitank gunners typically will face combat scenarios involving high-speed, high-threat vehicles delivering both munitions and troops under night conditions. Most of these target identifications will be made under mesopic or scotopic light levels, along with other meteorologic conditions [e.g., fog, rain, haze, heat scintillation ("boiling"), etc.] that may exist on the battlefield, all which will degrade visibility to levels far below the criteria involved in this test. These factors must be seriously examined before determining a final selection model.

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